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Studies on the biology and taxonomy of trematodes
of the genus *Tylodelphys* Diesing, 1850
(*Diplostomatidae*)

Badania nad biologią i systematyką przywr
z rodzaju *Tylodelphys* Diesing, 1850
(*Diplostomatidae*)

Observations on the trematodes of the genus *Tylodelphys* Diesing 1850 constituted a part of a collective study on the circulation of parasites in the biocenosis of Lake Drużno (1950—1951 and 1953), Lake Gołdapiwo (1954—1955) and Lake Mamry Północne (1956—1958) headed by the late Professor W. L. Wiśniewski; they were continued in 1958—1959 during studies on the parasitofauna of Lake Arklity (Mazury).

The experimental part was begun in collaboration with the late Professor Wiśniewski, but no definite results were obtained before his decease on August 24, 1958. It was concluded in 1959 during work on Lake Arklity.

The material was collected from the lakes according to a method described by Wiśniewski (1958) for Lake Drużno.

Observations concerned sexually mature trematodes parasitizing birds and metacercariae occurring in fish. The material collected was examined mostly for *Tylodelphys clavata* (Nordmann 1832) Diesing 1850. Development of metacercariae in natural infestation was followed, and Ciurea's (1928) experiments leading to an adult form in the definitive host were repeated. Experimental results obtained differed from those of Ciurea. The faunistic part includes figures and measurements of species subjected to experiments.

I. Faunistic and biology

Birds associated with the aquatic environment and inhabiting the region of the investigated four lakes were found to harbour four trematode species of the genus *Tylodelphys* Diesing 1850:

T. conifera (Mehlis 1864) Dubois 1937

T. podicipina Kozicka et Niewiadomska 1960

T. clavata (Nordmann 1832) Diesing 1850

T. excavata (Rudolphi 1803) Szidat 1935

Tylodelphys conifera (Mehlis 1864) Dubois 1937

It is the most common and numerous species in the investigated lakes, parasitizing three species of *Podicipedes*: *Podiceps cristatus* (L.), *P. griseigena* (Bodd.) and *P. nigricollis* Brehm. *P. cristatus* is the most common of these hosts in the Mazury lake region, while *P. griseigena* and *P. nigricollis* are rare species.

The occurrence of *T. conifera* is not identical in the investigated lakes. The highest intensity and extensiveness of invasion was observed in Lake Mamry Północne, while the lowest in Lake Drużno.

Table I

Occurrence of *T. conifera*

Host	Lake Drużno				Lake Gołdapiwo				Lake Mamry Pn.*			
	number of specimens examined	number of specimens invaded	intensity of invasion	extensiveness of invasion %	number of specimens examined	number of specimens invaded	intensity of invasion	extensiveness of invasion %	number of specimens examined	number of specimens invaded	intensity of invasion	extensiveness of invasion %
<i>Podiceps cristatus</i>	16	3	10-150	18.7	52	33	3-300	63.4	75	60	2-1500	80.0
<i>P. griseigena</i>	1	—	—	—	5	5	3-300	—	4	3	108-290	75.0
<i>P. nigricollis</i>	—	—	—	—	—	—	—	—	1	1	30	—

*Data supplied by Sulgostowska (1958)

The morphology of *T. conifera* collected by the authors (Fig. 1) is consistent with that described by Dubois (1938).

Measurements listed are those of a population of 170 specimens found in one bird. The trematodes were fixed in 75% alcohol without squashing. They were stored in alcohol and mounted in Canada balsam. Dubois measurements are listed for comparison purposes.

	Authors' measurements	Dubois' measurements (1938)
body length	0.95 — 1.36 mm	0.41 — 0.97 (0.53 — 0.73) mm
length of the anterior region of the body	0.57 — 0.88 mm	0.28 — 0.58 (0.35 — 0.49) mm
width of the anterior region of the body	0.36 — 0.47 mm	0.16 — 0.49 (0.20 — 0.38) mm
length of the posterior region of the body	0.24 — 0.60 mm	0.14 — 0.42 (0.17 — 0.24) mm
width of the posterior region of the body	0.24 — 0.38 mm	0.11 — 0.42 (0.16 — 0.29) mm
oral sucker	64 — 96 × 80 — 104 μ	36 — 70 × 34 — 77 (36 — 46 × 34 — 50) μ
pharynx	54 — 80 × 52 — 64 μ	27 — 65 × 18 — 50
ventral sucker	56 — 76 × 56 — 80 μ	21 — 50 × 31 — 77 (21 — 26 × 31 — 38) μ
holdfast organ	140 — 260 × 140 × 210 μ	82 — 130 × 80 — 285 (81 — 105 × 106) μ
ovary	48 — 60 × 68 — 88 μ	55 — 105 × 80 — 115 μ
testis I	92 — 114 × 209 — 342 μ	80 — 120 × 245 — 360 μ
testis II	96 — 133 × 190 — 285 μ	80 — 120 × 210 — 300 μ
egg	96 — 114 × 56 — 72 μ	105 — 110 × 63 — 75 μ
length of lateral sucker	90 — 136 μ	55 — 105 μ
esophagus	20 — 40 μ	8 — 24 μ

Specimens collected by the authors seem to be much larger. It is undoubtedly the result of various methods of preserving material. This collection includes *T. conifera* from *P. cristatus* kept in alcohol for nearly two years and subsequently stained and mounted in Canada balsam. The majority of trematodes range from 0.76 to 0.95 mm that is within the limits given by Dubois.

Tylodelphys podicipina Kozicka et Niewiadomska 1960

The species was found to occur in the same hosts as *T. conifera*, that is *P. cristatus* (L.), *P. griseigena* (Bodd.) and *P. nigricollis* Brehm, but the intensity and extensiveness of invasion was lower.

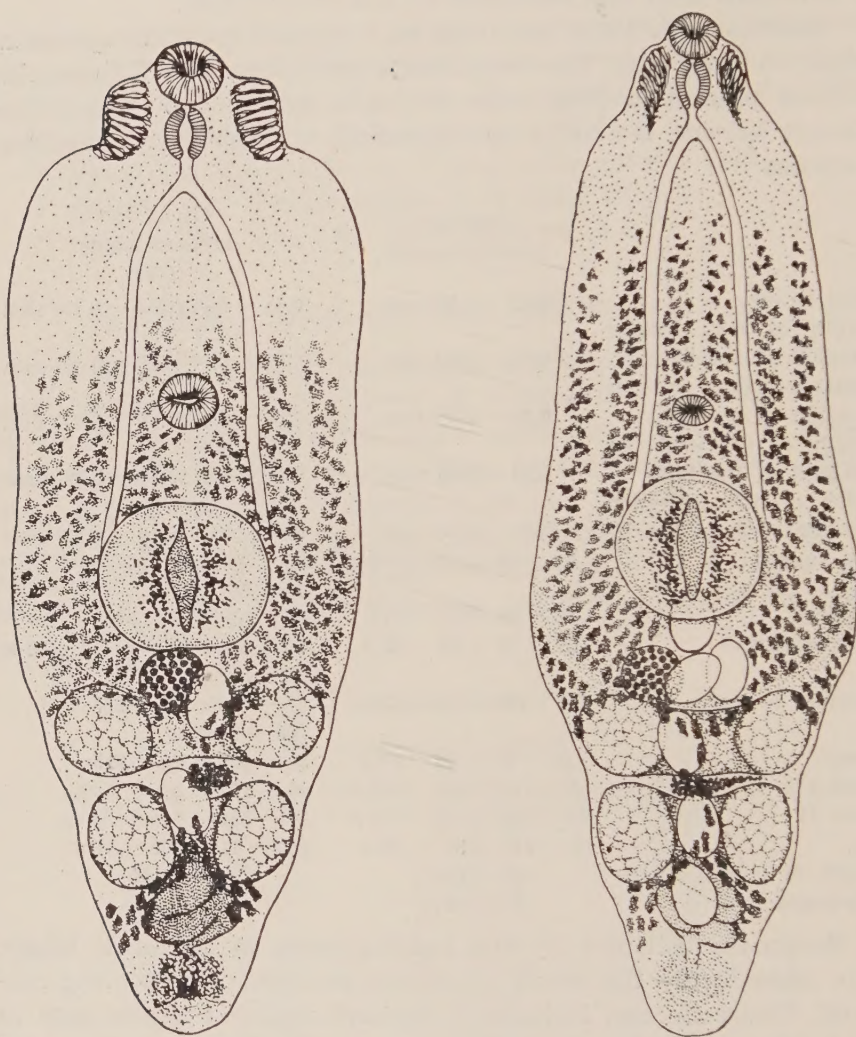


Fig. 1. *Tyloodelphys conifera* (Mehl.) from *Podiceps cristatus* Fig. 2. *Tyloodelphys clavata* (Nordm.) from *Circus aeruginosus*

Sulgostowska (1958) did not encounter this species in Lake Drużno. This may be explained by the comparatively small number of birds examined since the metacercaria of this species was found

Table II
Occurrence of *T. podicipina*

Host	Lake Goldapiwo				Lake Mamry Północne			
	number of specimens examined	number of specimens invaded	intensity of invasion	extensiveness of invasion %	number of specimens examined	number of specimens invaded	intensity of invasion	extensiveness of invasion %
<i>Podiceps cristatus</i>	52	11	up to 34	21.1	75	45	4—100	60.0
<i>P. griseigena</i>	5	1	2	—	4	3	20—50	75.0
<i>P. nigricollis</i>	—	—	—	—	1	1	10	—

Table III
Occurrence of *T. clavata*

Host	Lake Drużno				Lake Goldapiwo				Lake Mamry Pn.			
	number of specimens examined	number of specimens invaded	intensity of invasion	extensiveness of invasion %	number of specimens examined	number of specimens invaded	intensity of invasion	extensiveness of invasion %	number of specimens examined	number of specimens invaded	intensity of invasion	extensiveness of invasion %
<i>Circus aeruginosus</i>	3	1	—	—	3	—	—	—	7	1	72	14.3
<i>Ardea cinerea</i>	3	—	—	—	16	—	—	—	3	—	—	—

in that lake (see Table II). The highest extensiveness of invasion reaching 60 per cent was observed in Lake Mamry. The intensity of invasion ranged from 4 to 100 specimens.

Tylodelphys clavata (Nordmann 1832) Diesing 1850

The species was rare although *Circus aeruginosus* (L.) and *Ardea cinerea* L., reported in literature to be the definitive hosts of this trematode, were found in the investigated lakes (Table III). Both *C. aeruginosus* and *A. cinerea* were common in all the investigated lakes.

Extensiveness of invasion of *C. aeruginosus* with this trematode was very low. In Lake Mamry it amounted to 14.3%. The intensity of invasion of the one infected marsh harrier was 72 specimens. *Ardea cinerea* inhabiting the lakes did not harbour the worm.

Tylodelphys clavata collected by the authors is morphologically identical with that described by Dubois (1938). Their measurements are nearly identical. It is presented in Fig. 2. Measurements of collected *T. clavata* are compared with Dubois figures.

	Authors' measurements	Dubois' measurements (1938)
length of body	0.93 — 1.36 mm	0.79 — 1.17 mm
length of anterior region of the body	0.47 — 0.703 mm	0.49 — 0.73 mm
width of anterior part of the body	0.26 — 0.39 mm	0.25 — 0.42 mm
length of posterior part of the body	0.30 — 0.64 mm	0.26 — 0.44 mm
width of posterior part of the body	0.26 — 0.38 mm	0.20 — 0.29 mm
oral sucker	52 — 72 × 52 — 64 μ	46 — 88 × 37 — 85 μ
pharynx	40 — 52 × 36 — 48 μ	55 — 66 × 33 — 44 μ
ventral sucker	48 × 48 — 56 μ	44 — 66 × 55 — 72 μ
holdfast organ	190 — 220 × 90 — 128 μ	130 — 170 × 90 — 110 μ
lateral suckers	48 — 72 × 28 — 40 μ	41 — 99 × 26 — 53 μ
ovary	68 — 95 μ	50 — 70 × 70 — 100 μ
testis I	90 — 152 × 220 — 342 μ	60 — 100 × 170 — 260 μ
testis II	120 — 171 × 168 — 323 μ	70 — 140 × 150 — 250 μ
egg	100 — 110 × 60 — 68 μ	99 — 114 × 59 — 63 μ
esophagus	20 μ	11 — 22 μ

Tylodelphys excavata (Rudolphi 1803) Szidat 1935

The definitive host of this trematode, *Ciconia ciconia* L., is common in the Mazury lakeland. Examination of this bird was not planned as part of the present investigation. Only two storks were examined from the environs of Mamry Lake and both were invaded with *T. excavata*. The number of trematodes was 52 and 55 specimens.

The measurements and morphology of *T. excavata* collected by the authors are fully consistent with the description furnished by Dubois (1938).

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A simultaneous examination of fish revealed three species of metacercariae of the genus *Tylodelphys* Diesing 1859 parasitizing the fish, namely *Tylodelphys clavata* (Nordmann 1832) Diesing 1850, *T. podicipina* Kozicka et Niewiadomska 1960 and *T. craniaria* Diesing 1858.

Metacercariae of *Tylodelphys clavata* (Nordmann 1832)
Diesing 1850

It occurred in Lake Drużno, Goldapiwo and Mamry Północne in *Coregonus albula* L., *Esox lucius* L., *Rutilus rutilus* (L.), *Scardinus erythrophthalmus* (L.), *Tinca tinca* (L.), *Gobio gobio* (L.), *Blicca bjoerkna* (L.), *Abramis bramae* (L.), *Rhodeus sericeus* Bloch, *Carassius carassius* (L.), *Perca fluviatilis* (L.), *Lucioperca lucioperca* (L.), *Acerina cernua* (L.), and *Lota lota* (L.) (i. e. in a total of 14 species). Comparison of extensiveness and intensity of invasion of particular fish species in these lakes (Table IV) shows that the most heavily infested species is *P. fluviatilis*, which may be considered the primary host of *T. clavata*. Other species less severely infested are secondary hosts of this parasite.

The morphology of mature metacercaria of *T. clavata* (Fig. 3) does not differ from that reported by Ciurea (1928). The measurements of specimens collected by the authors are slightly larger. Measurements given are those of permanent mounts and heat killed specimens. Ciurea's (1928) figures are listed for comparison.

Table IV
Occurrence of metacercariae of *T. clavata*

Host	Lake Drużno				Lake Goldapiwo				Lake Mamry Pólcnoe			
	number of specimens examined	number of specimens invaded	intensity of invasion	extensiveness of invasion %	number of specimens examined	number of specimens invaded	intensity of invasion	extensiveness of invasion %	number of specimens examined	number of specimens invaded	intensity of invasion	extensiveness of invasion %
<i>C. albula</i>	—	—	—	—	134	11	1-6	8.2	88	1	3	1.1
<i>E. lucius</i>	63	30	1-118	48.0	34	3	1-150	8.8	75	14	1-40	18.6
<i>R. rutilus</i>	50	39	3-520	78.0	49	3	1-50	6.1	34	11	1-200	32.3
<i>S. erythrophthalmus</i>	22	11	1-300	50.0	11	3	1-6	27.2	50	3	1-100	6.0
<i>T. tinca</i>	28	7	1-8	25.0	—	—	—	—	21	1	3	4.7
<i>G. gobio</i>	10	1	15	10.0	—	—	—	—	—	—	—	—
<i>B. bjoerkna</i>	28	19	1-190	67.9	15	4	1-12	26.6	39	8	1-22	20.5
<i>A. brama</i>	49	36	1-140	73.0	17	4	8-15	23.5	42	10	4-30	23.8
<i>R. sericeus</i>	18	1	1	6.0	—	—	—	—	—	—	—	—
<i>C. carassius</i>	15	4	1-5	26.7	—	—	—	—	—	—	—	—
<i>P. fluviatilis</i>	58	57	17-800	93.0	90	53	1-1000	63.3	146	123	1-800	84.2
<i>L. lucioperca</i>	8	7	1-35	88.0	—	—	—	—	—	—	—	—
<i>A. cernua</i>	23	23	4-500	100.0	5	5	4-50	—	—	6	2-30	33.3
<i>L. lota</i>	—	—	—	—	—	—	—	—	27	5	7	18.5

	Authors' measurements		Ciurea's measurements
	fixed and mounted	heat killed	
body length	0.30 — 0.68 mm	0.47 — 0.74 (0.47 — — 0.95 mm in motion)	0.31 — 0.52 mm
body width	0.10 — 0.19 mm	0.15 — 0.20 (0.28 — — 0.90 mm in motion)	0.10 — 0.15 mm
oral sucker	28 — 44 × 24 — 36 μ	36 — 48 × 28 — 44 μ	42 × 33 μ
pharynx	20 × 12 μ	28 — 32 μ (length)	24 × 15 μ
ventral sucker	18 — 24 × 20 — 28 μ	16 — 32 × 24 — 32 μ	24 × 24 μ
holdfast organ	52 — 84 × 28 — 40 μ	68 — 80 × 32 — 48 μ	59 × 37 μ

The high intensity of infestation of *Perca fluviatilis* (L.) with metacercariae of *T. clavata*, ranging from 1 to 1000 specimens allowed for tracing the development of this metacercaria in natural condition from the earliest stages up to a fully developed metacercaria.

The youngest stage encountered in natural invasion (Fig. 4) retains morphological features common with the cercaria (Niewiadomska, 1960). Body dimensions are slightly larger than those of cercariae. At the anterior end there is the holdfast organ covered with rows of spines forming a checker-board and decreasing in size toward the posterior. The spines extend up to nearly half the length of the anterior organ. Above the mouth cavity there are two rows of more powerful spines, the lower one made up of 5 spines and the upper one of 8. The ventral sucker is located slightly posterior to the centre of the body. It is markedly protracted and furnished with a wreath of powerful spines with hook shaped ends, numbering from 35 to 40. The digestive tract is quite visible. The caeca are long, undulating and extend practically to the posterior end of the body. Above the ventral sucker at the bifurcation of the intestine lie the vestiges of the penetration glands. The terminal parts of the ducts of the penetration glands have also survived.

Measurements of the youngest stage:

body length	0.27—0.16 mm
body width	0.024—0.035 mm
anterior organ	0.056×0.024 mm
ventral sucker	0.024—0.027×0.027—0.030 mm

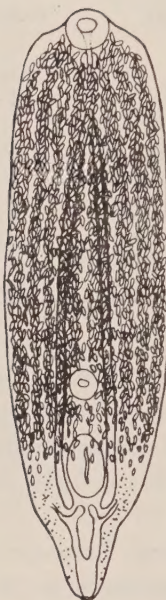


Fig. 3. Metacercaria of *T. clavata* (Nordm.) from the eye of *Perca fluviatilis*



Fig. 4. The youngest stage of metacercaria of *T. clavata* (Nordm.) from natural invasion in *P. fluviatilis*

The next stage of development is a metacercaria reaching the length of 0.30 to 0.40 mm and width of 0.07 to 0.05 mm. The spines are observable both in the anterior part of the body and on the ventral sucker. The body becomes less transparent due to minute granules appearing inside of it. The digestive tract is unobservable (Fig. 5a).

The metacercaria continues to grow and reaches the dimensions of 0.48 by 0.12 mm. The number of minute granules in the body increases. The body becomes even more opaque. The intestine is still not apparent (Fig. 5b). The anterior organ begins to transform into the oral sucker. Pharynx becomes observable (24 by 16 μ). The ventral sucker (32 by 33 μ) is still armed with hooks.

Subsequent development of the metacercaria leads to the formation of a holdfast organ. Metacercaria (Fig. 5c) measures by then 0.49 by 0.16 mm. The oval holdfast organ develops posteriorly to the ventral sucker. The ventral sucker has no more spines. The

oral sucker is not yet completely formed. Body still opaque. No observable digestive tract.

Since the appearance of small granules inside the body of metacercaria, observation of the excretory system becomes impossible. Not until the metacercaria is definitively developed (Fig. 5d) does the body again become transparent. It then measures 0.60

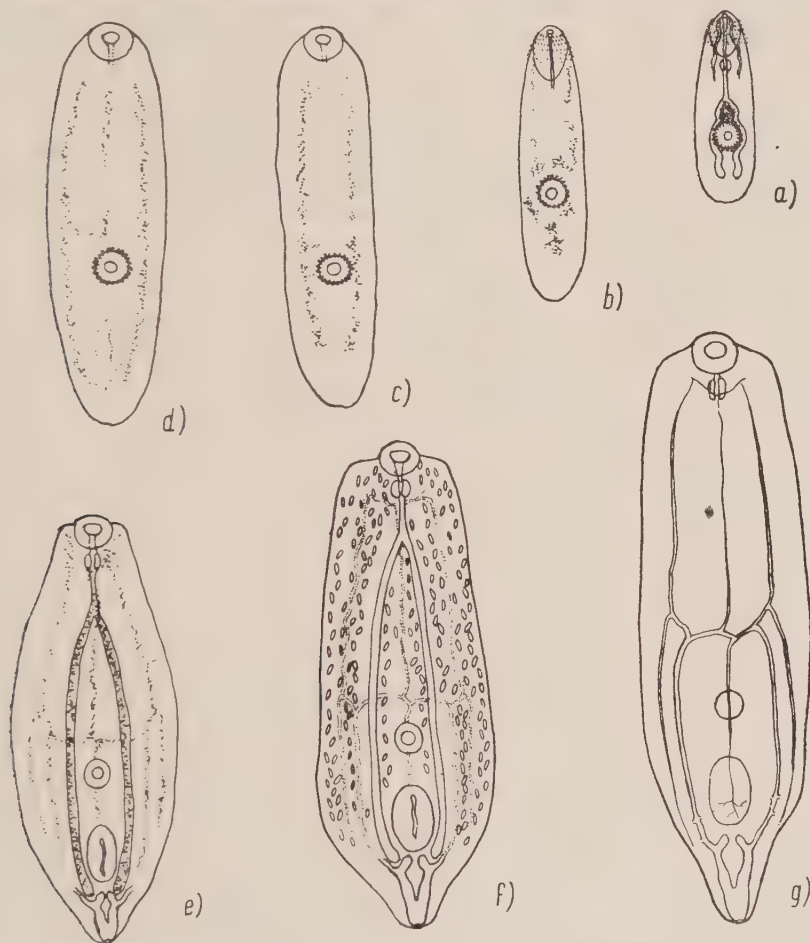


Fig. 5. Successive stages of development of metacercaria of *T. clavata* (Nordm.) in the eye of *P. fluviatilis* in natural invasion

by 0.20 mm. Oral sucker and pharynx are well developed, oesophagus is quite long. The intestine bifurcates at about $\frac{1}{4}$ the distance between the pharynx and ventral sucker. The caeca are long and

narrow extending nearly to the posterior end of the body. The ventral sucker is smaller than the oral one, being situated posteriorly to the centre of the body. Behind it lies a large oval holdfast organ opening in a longitudinal median groove. The outlines of elongate excretory canals are visible. At this stage of development the metacercaria already has a tail. In the tail there is a Y-shaped excretory vesicle. The median branch of the vesicle is long while the lateral branches diverge and envelop the ends of the intestine. The whole metacercaria is flat and leaf shaped.

Further changes result in a metacercaria that is still light and leaf shaped (Fig. 5e), measuring 0.60 by 0.20 mm, with excretory bodies beginning to appear in it. They are initially few, oval shaped and loosely packed along the longitudinal excretory canals. The body of the metacercaria is still transparent.

Developed metacercariae (Fig. 3) have a dark body, completely packed with oval excretory granules, dark and strongly reflecting light. It is again opaque. The body is still leaf shaped, although slightly thicker. From the posterior end of the body there projects a prominent conical tail bent dorsally. It is very mobile, contracting quickly and twisting to the sides. This causes marked apparent differences in the length of the body. Observation of internal organs such as the intestine and the excretory system is practically impossible due to the great number of excretory bodies. In one specimen it was possible to observe the course of the main excretory canals (Fig. 5f). Two canals run anteriorly from the excretory vesicle bifurcating at about half the length of the body. One branch goes forward to the oral sucker giving off several side branches along its course and dividing into small branches in the vicinity of the pharynx and sucker. The second branch of the main canal runs toward the posterior end. Slightly below the point of bifurcation of the main trunk and before the ventral sucker there is a transverse commissure, which grows up to give two trunks running along the median line of the body. One of them runs forward and terminates in small branches in the vicinity of the pharynx joining also the two fore-trunks. The other runs posteriorly and reaches the posterior margin of the holdfast organ. To the sides of all the canals go off small canaliculi terminating in excretory granulas. The morphology of the excretory system observed by the authors is consistent with that given by Hattwich et Odening (1958) for metacercaria of *Tylodelphys excavata* (Rudolphi, 1803) Szidat 1935.

Metacercaria Tylodelphys podicipina K o z i c k a
et N i e w i a d o m s k a 1960

This metacercaria occurred in all the three lakes studied. It was found in three species of fish: *Perca fluviatilis* (L.), *Lota lota* (L.) and *Acerina cernua* (L.). The invasion of fish was lowest in Lake Družno and highest in Mamry Północne. *P. fluviatilis* was the most intensely infected species (Table V).

Table V
Occurrence of metacercariae of *T. podicipina*

Host	Lake Družno				Lake Gołdapiwo				Lake Mamry Pn.			
	number of specimens examined	number of specimens invaded	intensity of invasion	extensiveness of invasion %	number of specimens examined	number of specimens invaded	intensity of invasion	extensiveness of invasion %	number of specimens examined	number of specimens invaded	intensity of invasion	extensiveness of invasion %
<i>Perca fluviatilis</i>	58	2	1-2	3.4	131	8	1-2	6.1	146	43	1-3	29.4
<i>Lota lota</i>	—	—	—	—	—	—	—	—	42	6	4-15	14.3
<i>Acerina cernua</i>	—	—	—	—	5	1	1	20.0	9	1	1	11.1

Metacercaria Tylodelphys craniaria Diesing 1858

Occurs only in *Misgurnus fossilis* (L.). The host is rare in studied lakes. Two loaches of the Lake Družno were examined and were found to be uninfected. One specimen from Lake Mamry was examined and found to contain two specimens of *Tylodelphys craniaria* in the cerebrospinal fluid.

II. Experimental

There is considerable discrepancy between the intensity and extensiveness of infestation of fish with metacercariae of *Tylodelphys clavata* and intensity and extensiveness of invasion of definitive hosts, *Circus aeruginosus* (L.) and *Ardea cinerea* L., with the adult form of this trematode (Table VI). The invasion of fish is marked reaching in *P. fluviatilis* (L.), the primary intermediate host of this metacercaria, 79.2% with intensity ranging from 1 to 1000 specimens. *A. cinerea* was not invaded in any of the studied lakes, while *C. aeruginosus* was invaded in 15.3% at intensity equal to 72 specimens. At the same time the invasion of *Podicipedes* with *Tylodelphys conifera* (Mehlis 1864) Dubois 1937 was remarkably high, reaching 71.5% in the most common in these lakes *Podiceps cristatus* (L.), with intensity ranging from 3 to 1500 specimens. Metacercaria of this trematode was not found in these lakes; a total of 3695 fish belonging to 27 species was examined (Table VI).

It seemed probable that *T. conifera* may develop in grebes from the metacercaria of *T. clavata*. In order to solve this problem, the authors considered it necessary to repeat experiments on the last stage of the life-cycle of *T. clavata*, performed already by Ciurea (1928).

Ciurea found metacercariae of *Tylodelphys clavata* in the following species of Danube fish: *Perca fluviatilis* (L.), *Lucioperca lucioperca* (L.), *Lucioperca volgensis* (Pall.), *Acerina cernua* (L.), *Aspro streber* (Sieb.), *Abramis brama* (L.), *Abramis ballerus* (L.), *Abramis sapa* (Pall.), *Scardinius erythrophthalmus* (L.), *Carassius carassius* (L.), *Tinca tinca* (L.), *Leuciscus rutilus* (L.), *Idus idus* (L.), *Blicca bjoerkna* (L.), *Aspius aspius* (L.) and *Esox lucius* (L.).

Ciurea infected young female of *C. aeruginosus* with metacercariae from the eyes of *P. fluviatilis* and *A. cernua*. The metacercariae contained in the eyes of fish were introduced for three successive days. The bird received a total of 38 eyes of *P. fluviatilis* and 8 eyes of *A. cernua*. The bird was sectioned on the fourth day and found to contain 604 specimens of *T. clavata*, the development of which corresponded to the three successive infestations. Ciurea obtained a positive effect also in case of *Ciconia ciconia* (L.) kept in the laboratory for 23 days preceding infestation with these metacercariae. His experiments proved negative in case of: *Platalea leucorodia* L., *Falco subbuteo* L., *Egretta*

Table VI

Invasion of fish and birds with metacercariae and adult *T. clavata* and *T. conifera* (total for all the lakes studied)

Metacercariae <i>T. clavata</i>			<i>T. clavata</i>			<i>T. conifera</i>		
Host	intensity of invasion	extensiveness of invasion %	Host	intensity of invasion	extensiveness of invasion %	Host	intensity of invasion	extensiveness of invasion %
<i>C. albula</i>	1—6	5.4	<i>C. aeruginosus</i>	72	15.3	<i>P. cristatus</i>	3—1500	71.5
<i>E. lucius</i>	1—150	27.3	<i>A. cinerea</i>	0	0	<i>P. griseigena</i>	100—200	77.7
<i>R. rutilus</i>	1—520	39.8				<i>P. nigricollis</i>	up to 50	
<i>S. erythrophthalmus</i>	1—300	20.4						
<i>T. tinca</i>	1—8	16.3						
<i>G. gobio</i>	15	10.0						
<i>B. bjoerkna</i>	1—190	37.8						
<i>A. brama</i>	1—140	46.3						
<i>R. sericeus</i>	1	6.0						
<i>C. carassius</i>	1—5	26.7						
<i>P. fluviatilis</i>	1—1000	79.2						
<i>L. lucioperca</i>	1—35	88.0						
<i>A. cernua</i>	4—500	73.9						
<i>L. lota</i>	1—35	18.5						

garzetta (L.), *Fulica atra* L., *Heliaëtus albicilla* (L.), *Botaurus stellaris* (L.) *Archibuteo lagopus* Gmel., *Buteo vulgaris* Leach., and nestlings of domestic hen and duck.

The ouer experiments went in two directions: 1) repetition of Ciurea's experiments consisting in infecting young *Circus aeruginosus* with metacercariae of *Tylodelphys clavata* from the eyes of *P. fluviatilis* in order to obtain adult *T. clavata* and 2) infestation of *Podiceps cristatus* nestlings with the same metacercariae in order to ascertain whether they will not develop into *T. conifera*.

In 1957 two nestlings of *C. aeruginosus* 1—2 weeks old were taken from a nest and reared in laboratory. The birds were kept in large cages and fed with meat and beheaded fish. After about a month all the birds were infected. The infestation was performed by placing the metacercariae together with the eye fluid and the vitreous humor in a piece of meat which the bird swallowed at once. The number of metacercariae introduced was estimated approximately before placing them in meat. The invasiveness of larvae was not studied. The first bird received three feedings of 200 metacercariae each at 10 day intervals. It was examined a month after the last feeding — no *T. clavata* was found in the intestine. The second bird was infected seven times within 24 days with servings of metacercariae ranging from 25 to 200. It received a total of 900 metacercariae of *T. clavata*. When sectioned three days after the final infestation, it did not harbour any young or mature specimens of *T. clavata* in the intestine.

In 1958 a young, about three days old *P. cristatus* was caught at the lake. For two weeks it was reared in laboratory and fed fish muscles and liver mixed with some feather of an adult bird. Subsequently it was given two servings (about 300 and 800 specimens at an interval of 15 days) of metacercariae of *T. clavata* placed in the body cavity of small beheaded bleak.

The bird was examined 9 days after the last experimental feeding. The intestine was found to harbour 70 mature *Tylodelphys conifera*. The small number of adult worms obtained in comparison with the number of metacercariae introduced could be explained as follows: the large number of metacercariae introduced could have an inhibitory effect on their development; the developmental abilities of metacercariae could decrease as a result of refrigeration of fish from which they were obtained. It could also be assumed that the trematodes found were derived from natural infestation in the lake.

The result called for repetition of the experiment.

In 1959 the experiments were repeated with both *Podiceps cristatus* and *Circus aeruginosus* inhabiting Lake Arklity. Two marsh-harriers taken from a nest were reared for two weeks under similar conditions as in previous experiments. One was fed about 2100 metacercariae of *T. clavata* in servings of about 500, 600 and 1000 specimens at 3 and 5 days intervals. The metacercariae were served as previously in a piece of meat which the bird swallowed in one gulp. The bird was examined on the third day following the last experiment. *T. clavata* was not found in the intestine. The second bird was given metacercariae together with eyes of *P. fluviatilis*. The idea was to create conditions identical to those in Ciurea's experiments (1928) in order to exclude the possibility of unfavourable effects that squeezing out metacercariae with the vitreous humor and the eye fluid from the eye ball and placing them in a piece of meat might have on them. The bird was given 30 eyes of *P. fluviatilis*, which considering the degree of infection in the Arklity (intensity of invasion 1 to 100, extensiveness 97.6%, mean maximum infestation 122.15) contained about 2000 metacercariae of *T. clavata*. The eyes were placed in the birds pharynx at two feedings, 10 eyes at first and after four days another 20 eyes. Swallowing was observed and the bird remained under observation for some time in order to insure that the bird did not spit the eyes out. The bird was examined three days after the last feeding and found to contain no *T. clavata* in its intestine.

At the same time four weeks old *P. cristatus* laboratory reared for two weeks beforehand was infected with metacercariae of *T. clavata* from the eyes of *P. fluviatilis*. The bird received 80, 200, and 50 metacercariae at two days intervals. It was examined on the day following the last feeding. 90 specimens of *T. conifera* of developmental stages corresponding to the particular experimental feedings were found in the intestine. Specimens in the particular stages of development found in the intestine numbered beginning with the youngest ones 20, 26 and 44.

The youngest, one day stage (Fig. 6a) is morphologically little different from the metacercariae. The body is elongate, although already slightly widened. At the anterior end of the body there are prominent lateral suckers and the specimen is markedly tripartite. The oral sucker is larger than the ventral one, pharynx large and pronounced, esophagus short. The caeca are long and narrow,

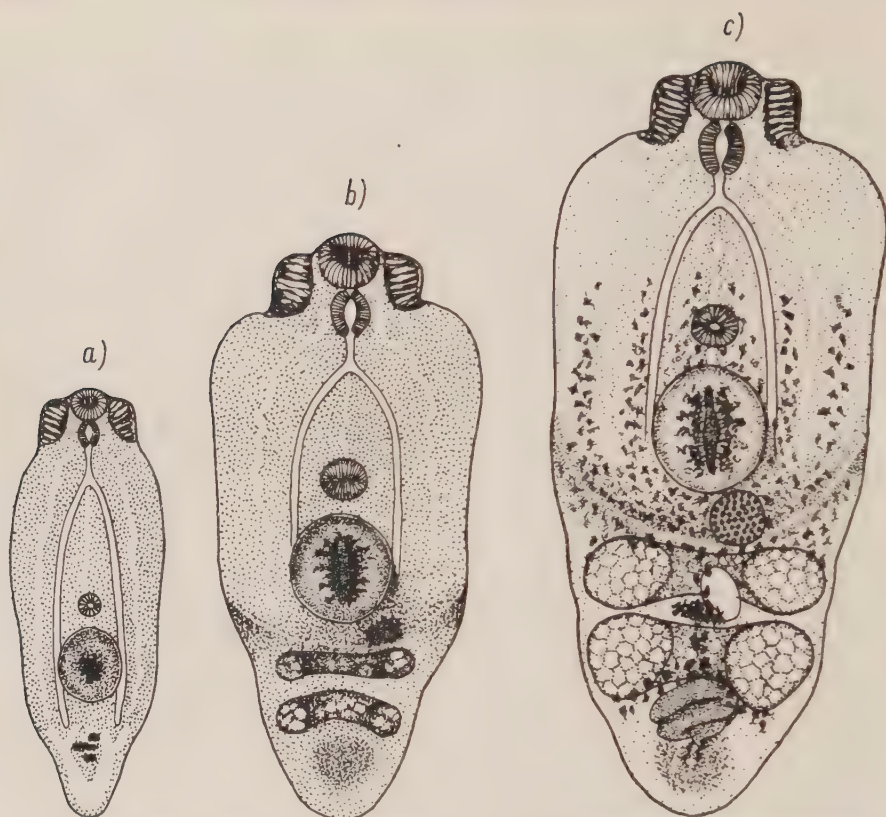


Fig. 6. Successive stages of development of „*T. conifera* (Mehl.)” in experimental invasion in *P. cristatus*

extending to the base of the tail. The holdfast organ is round or oval. Posterior to the holdfast organ there are already separate primordia of ovary and both testes.

Measurements of the youngest trematode stage:

body length	0.53 mm
body width	0.17 mm
length of posterior part	0.12 mm
oral sucker	$40 \times 60 \mu$
pharynx (length)	36μ
ventral sucker (diameter)	35μ
holdfast organ	$95 \times 80 \mu$
lateral suckers	$52 \times 32 \mu$

Three days stage (Fig. 6b). The body grows, particularly in its posterior part where the reproductive organs develop. The ovary

develops laterally on the border between both segments. Posteriorly to it lie the two developing tubular, horseshoe shaped testes, so far some distance apart from one another. Posterior to them pronounced cluster of cells at the place where the bursa copulatrix and vesicula seminalis is to form. In the anterior part outlines of the main excretory canals are visible.

Measurements:

body length	0.72 mm
body width	0.34 mm
length of anterior part	0.49 mm
length of posterior part	0.22 mm
oral sucker	56 × 80 μ
pharynx	68 × 60 μ
ventral sucker	38 × 56 μ
holdfast organ	140 × 133 μ
testis I	28 × 172 μ
testis II	40 × 168 μ
ovary	32 × 28 μ
lateral suckers	80 × 42 μ

5 days stage (Fig. 6c). The trematode is fully developed but does not reach its definitive size. Vitellaria appear, located as in completely mature trematodes. The vitelline follicles are minute and widely dispersed. A vitelline vesicle appears between the testes. The testes are horseshoe shaped and practically adjacent to one another. The bursa copulatrix and the seminal vesicle is already developed. First eggs begin to appear.

Measurements:

body length	0.96 mm
body width	0.38 mm
length of anterior part	0.58 mm
length of posterior part	0.38 mm
oral sucker	56 × 80 μ
pharynx	68 × 60 μ
ventral sucker	48 × 60 μ
holdfast organ	152 × 152 μ
testis I	82 × 304 μ
testis II	114 × 285 μ
ovary	52 × 72 μ
egg	64 × 44 μ

The last problem which the authors were concerned with was whether the morphologically identical metacercariae of *T. clavata* inhabiting the eyes of the cyprinid fishes will also develop into

T. conifera or whether they are the metacercariae of a closely related species which does not occur in *Podicipedes*.

A young grebe was fed metacercariae derived from *C. carassius* and *R. rutilus*. It received about 130 metacercariae in six feedings of 10 to 50 specimens in the course of 14 days, and was examined two days after the last feeding. The intestine was found to contain 40 young and mature *T. conifera* (Table VII).

Table VII
Experimental results

Bird invaded	Number of metacercariae introduced	Number of days after last infestation	Result of experiment
	Metacercariae of <i>T. clavata</i> from the eyes of <i>P. fluviatilis</i>		
<i>Circus aeruginosus</i>	about 600 (3 feedings of about 200 specimens at 10 days intervals)	30	negative
<i>C. aeruginosus</i>	about 900 (7 feedings. Number of metacercariae per feeding ranging from 25 to 200, introduced within 24 days)	3	"
<i>C. aeruginosus</i>	about 2100 (feedings of about 500, 600 and 1000 at 3 and 5 days intervals)	3	"
<i>C. aeruginosus</i>	30 eyes of <i>P. fluviatilis</i> — about 1500 (10 and 20 eyes at 4 days intervals)	3	"
<i>Podiceps cristatus</i>	about 1100 (300 and 800 at 15 days intervals)	9	70 <i>T. conifera</i>
<i>P. cristatus</i>	about 330 (feedings of about 80, 200 and 50 at 2 days intervals)	1	90 <i>T. conifera</i>
	Metacercariae of <i>T. clavata</i> from the eyes of <i>C. carassius</i> and <i>R. rutilus</i>		
<i>P. cristatus</i>	about 130 (in 6 feedings of 10 to 50 specimens within 14 days)	2	40 <i>T. conifera</i>

III. Analysis of results

Repetition of Ciurea's (1928) experiments for the purpose of obtaining mature *T. clavata* in *Circus aeruginosus* gave negative results. Metacercariae of *T. clavata* (Nord.) failed to develop in *C. aeruginosus*. A positive effect was obtained in infecting *Podiceps cristatus* with these metacercariae. They developed into *T. conifera* (Mehli.), a parasite typical for this bird species.

Results of our experiments are in agreement with relations observed in the lake biocenosis. Metacercaria of *T. clavata* is the most common one in the lake and extensity of invasion of its primary host *Perca fluviatilis* reaches 79.2% (intensity of invasion ranging from 1 to 1000). *T. conifera*, the definitive form obtained from it, is a very common trematode parasitizing *Podicipedes*. The extensiveness of infestation of its primary host in lakes covered by the investigation, *Podiceps cristatus*, amounts to 77.7% with intensity ranging from 3 to 1500 (Table VI). The definitive hosts of mature *T. clavata* given by Ciurea (1928) were in these lakes either uninfested (*Ardea cinerea*) or infested to only a small extent (*Circus aeruginosus*, 15.3%);

The authors were not able to elucidate the discrepancy between their own and Ciurea's results. It is not known what would have been Ciurea's results had he infected *P. cristatus* with eyes of *P. fluviatilis* containing metacercariae of *T. clavata*. Perhaps further studies will help to elucidate this point.

It seems that results obtained by the authors entitle them to correct the specific name of the trematode developing in *Podiceps* sp. sp. from metacercariae of *T. clavata* (Nordmann, 1832) Diesing 1850 and referred to as *T. conifera* (Mehlis, 1864) Dubois 1937. According to the rules of nomenclature, it obtains, on the basis of priority, the larval name:

Tylodelphys clavata (Nordmann 1832) Diesing 1850.

Synonyms: *Diplostomum clavatum* Nordmann 1832

Tylodelphys clavata Diesing 1850

Holostomum coniferum Mehli 1864

Tylodelphys conifera Dubois 1937

nec: *Proalaria clavata* Ciurea 1928

nec: *Tylodelphys clavata* Hughes 1929.

The trematode parasiting in nature *Circus aeruginosus*, which does not develop from the metacercaria *T. clavata* will until the discovery of its metacercaria be referred to as heretofore as:

Tylodelphys clavata (Ciurea 1929) Hughes 1929.

Synonym: *Proalaria clavata* Ciurea 1928

nec: *Tylodelphys clavata* (Nordmann 1832) Diesing 1850.

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STRESZCZENIE

U ptaków związanych ze środowiskiem wodnym na jeziorach Drużno, Gołdapiwo i Mamry Północne występują cztery gatunki przywr z rodzaju *Tylodelphys* Diesing 1850: *T. conifera* (Mehl.), *T. podicipina* Koz. Niew., *T. clavata* (Nord.) i *T. excavata* (Rud.). W rybach na wymienionych jeziorach znaleziono trzy gatunki metacerkarii należących do rodzaju *Tylodelphys*: *T. clavata* (Nord.), *T. podicipina* Koz. Niew. i *T. craniaria* Dies.

Prześledzony został rozwój metacerkarii *T. clavata* w zarażeniu naturalnym od stadiów najmłodszych do dojrzałej metacerkarii.

Autorki powtórzyły doświadczenia Ciurea (1928), który zarażając *Circus aeruginosus* (L.) metacerkariami *T. clavata* z oczu *Perca fluviatilis* (L.) otrzymał w nim postacie dojrzałe tej przywry. Otrzymane wyniki okazały się niezgodne z Ciurea. Metacerkarie *T. clavata* nie rozwijały się w *C. aeruginosus*. Pozytywny wynik otrzymano zarażając tymi metacerkariami *Podiceps cristatus* (L.). W wyniku otrzymano typowego dla tego gatunku żywiciela pasożyta — *T. conifera*. Wynik doświadczeń zgodny jest z obserwowanymi przez autorki stosunkami panującymi w biocenozie jeziornej.

Na podstawie powyższych doświadczeń autorki uważają za słuszne skorygowanie nazwy gatunkowej przywry rozwijającej się w *P. cristatus* z metacerkarii *T. clavata*, a znanej dotychczas pod nazwą *T. conifera*. Zgodnie z zasadami priorytetu przyjmuje ona nazwę swej metacerkarii — *T. clavata* (Nordmann 1832) Diesing 1850 (nec *Proalaria clavata* Ciurea 1928; nec *Tylodelphys clavata* Hughes 1929). Występującą w *C. aeruginosus* przywrę, która nie rozwija się z metacerkarii *T. clavata*, autorki pozostawiają z dotychczasową nazwą *Tylodelphys clavata* (Ciurea 1928) Hughes 1929 (nec *T. clavata* (Nordmann 1832) Diesing 1850) do czasu znalezienia odpowiadającej jej metacerkarii.

